**Price FDU - Underfloor Fan Powered Booster & Terminal Unit**

# Division 23 – Heating, Ventilating, and Air Conditioning Section 23 36 16 – Variable Air Volume Units

The following specification is for a defined application. Price would be pleased to assist in developing a specification for your specific need.

## PART 1 – GENERAL 1.01 Summary

A. This section includes the following:

 1. Underfloor fan powered booster and terminal units

## 1.02 Related Requirements

1. 23 01 00 – Operation and Maintenance of HVAC Systems
2. 23 05 00 – Common Work Results for HVAC
3. 23 09 00 – Instrumentation of Control for HVAC
4. 23 20 00 – HVAC Piping and Pumps
5. 23 30 00 – HVAC Air Distribution

## 1.03 Reference Standards

1. All referenced standards and recommended practices in this section pertain to the most recent publication thereof, including all addenda and errata.
2. AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils.
3. AHRI 880 - Performance Rating of Air Terminals.
4. AHRI 885 - Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.
5. ASTM E488/E488M - Standard Test Methods for Strength of Anchors in Concrete Elements.
6. CSA C22.2 No. 236 – Heating and Cooling Equipment.
7. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
8. NFPA 70 - National Electrical Code.
9. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association.
10. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.
11. UL 1995 – Standards for Heating and Cooling Equipment.

## 1.04 Submittals

1. Product Data: For each type of product indicated, include rated capacities, furnished specialties and accessories.
2. Shop Drawings: For each type of product indicated, include the following:
	1. Detail equipment assemblies and indicated dimensions.
	2. Required clearances.
	3. Method of field assembly.
	4. Revit models
3. Coordination Drawings: Include floor plans, and other details, drawn to scale, one which the following items are shown and coordinated with each other, based on input from installers of the items involved:
	1. Floor or underfloor-mounted items including;
		1. Floor structure (floor tiles, concrete, etc.)
		2. Floor finishing (carpet, tile, etc.)
		3. Access panels
		4. Electrical components
		5. Plumbing
		6. Networking components
		7. Terminal Units and other HVAC components
4. Operation and Maintenance Data: To include in emergency, operation and maintenance manuals, maintenance schedules and repair part lists for all parts.

## 1.04 Quality Assurance

1. Product Options: Include drawings indicating size, profiles and dimensional requirements of the linear floor heaters that are based on the specific system indicated.
2. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100 by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

## 1.05 Coordination

1. Coordinate layout and installation of diffusers with other construction that penetrates flooring, including but not limited to: electrical fixtures, network equipment, HVAC equipment, and partition assemblies.
2. Specific configuration of the supply and return ductwork, electrical work, and piping at each unit has been indicated on the drawings. If the configuration of the units furnished on the project differs from that indicated on the drawings (whether or not the units furnished are the specific units or an acceptable substitute), it shall be the contractor’s responsibility to modify ductwork, piping, etc., as required to accommodate the actual configuration of units furnished on the project.

**PART 2 – PRODUCTS**

## 2.01 Manufacturer

1. Basis of Design: Price Industries, Inc.

 1. Underfloor Fan Powered Booster & Terminal Unit: Model FDU

1. General:
	* 1. Manufacturer shall be responsible for examining applications of each type of unit to assure that each will operate properly in the intended application.
		2. Unit sizes are shown as selected in accordance with the principles set forth in the ASHRAE Guide and manufacturer’s literature.
		3. All items of a given type shall be the products of the same manufacturer.
		4. Manufacturers shall demonstrate that they have successfully supplied and installed underfloor HVAC products, as well as the computer modeling thereof for a minimum of 10 years. Manufacturers must be pre-qualified to bid based on the completion of a minimum of xx jobs in similar climates. Manufacturers shall provide a list of completed jobs and references

**2.02 Underfloor Fan Powered Booster & Terminal Unit**

A. Description:

1. Furnish and install Price underfloor fan powered units (FDU) of the sizes and capacities as shown on the plan.
2. Performance:
	1. The air terminal unit shall be designed, installed and field adjusted, if necessary, to maintain controlled air flow.
	2. Sound ratings of air distribution assemblies shall not exceed \_\_NC at the downstream static pressure of\_\_.
3. Unit Casing:
	1. The unit casing shall be constructed of zinc coated galvanized steel with a minimum material thickness of 20 gauge.
	2. Access panel shall be on top of the unit.
	3. Primary air inlet collar [Terminal configuration only]: Manufacturer shall provide round inlet collars, suitable for standard flexible duct sizes.
	4. Unit Discharge: Manufacturer shall provide rectangular unit discharges, suitable for flanged duct connection.
	5. Liners:
		1. Standard:
			1. ½” Fiberglass Liner – FG50
				1. Insulation shall comply with the requirements of UL 181 (erosion), ASTM C1338 (fungi resistance), ASHRAE 62.1, and ASTM C1071, having a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
				2. The insulation shall be secured with adhesive.
				3. Insulation edges exposed to the airstream shall be coated with NFPA 90A approved sealant.
				4. Insulation thickness shall be 0.5 inch thick, R-value of 2.1.

* + 1. Optional:
			1. ½” Fiber-Free Foam Insulation – FF50.
				1. Insulation shall comply with UL 181 erosion, mold growth, and humidity requirements in accordance with ASHRAE 62.1, and shall have a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
				2. The insulation shall be secured with adhesive.
				3. Insulation thickness shall be 0.5 inch thick, R-value of 2.0.
1. Primary Air Damper Assembly [Terminal configuration only]:
	1. The damper assembly shall be heavy-gauge, galvanized steel with a solid shaft rotating in bushings.
	2. The damper shaft shall incorporate a visual position indicator etched into the end of the damper shaft to clearly indicate damper position over the full range of 90 degrees.
		1. The damper shaft shall be mounted on the [left], or [right] of the damper when looking in the direction of airflow.
	3. The low leakage 18 gauge damper assembly shall incorporate a peripheral gasket on the damper blades for tight airflow shutoff.
		1. Air leakage past the closed damper shall not exceed two percent of the unit maximum airflow at 3 inch water gauge inlet static pressure, tested in accordance with ASHRAE 130.
		2. The damper, seal and bushing system shall be tested to 1.25 million cycles, or the equivalent of 100 full open/closures per day for 35 years, with no visible signs of wear, tear, or failure of the damper assembly after such testing.
	4. Airflow Sensor:
		1. The airflow sensor shall be a differential pressure airflow device measuring total and static pressure, and shall be mounted to the inlet valve.
		2. Plastic parts shall be fire-resistant, complying with UL 94.
		3. The airflow sensor shall be RoHS (Restriction of Hazardous Substances) compliant. Materials containing polybrominated compounds shall not be acceptable.
		4. Control tubing shall be protected by grommets at the wall of the airflow sensor's housing.
		5. The airflow sensor shall be furnished with a minimum of twelve total pressure sensing ports and four static pressure sensing ports, and shall include a center averaging chamber that amplifies the sensed airflow signal.
		6. The airflow sensor signal accuracy shall be plus or minus five percent throughout unit operating range.
	5. Inlet Valve:
		1. The inlet valve shall be a consistent diameter to retain flex duct and provide a stop for hard duct, except for inlets below six inches. Inlets smaller than six inches shall use a six inch duct capped with a reducer transition.
		2. The inlet valve shall include a 1/8 inch raised single bead weld for added strength.
			1. Transition pieces for inlets smaller than six inches will not have a single bead weld.
		3. The gasket seal shall be a low leakage continuous piece with a peripheral gasket for tight airflow shutoff.
		4. The inlet valve shall include heavy-duty stop pins to accurately position the damper in the open and closed position.
2. Fan Motor:
	1. Electrically Commutated Motor (ECM)
		1. The motor shall be an Electronically Commutated Motor (ECM), and the motor shaft shall be directly connected to the fan.
		2. The brushless DC motor shall be controlled by an integrated controller/inverter that operates the wound stator and senses rotor position to electrically commutate the stator. The motor shall be supplied with a speed controller. The speed controller shall have dual outputs to control up to two motors, and allow for manual dial motor speed adjustment, or a [2-10 VDC] or [4-20 mA] signal for variable speed control.
			1. Permanent magnet type motor with near-zero rotor losses designed for synchronous rotation.
			2. Designed to maintain a minimum 70 percent efficiency over the entire operating range.
			3. The ECM shall be furnished with factory programming (**select one**):
				1. High Turndown Program:

A high turndown program shall be provided to allow the ECM to operate with constant torque to vary the airflow with fluctuations in external static pressure.

The motor shall be capable of operating at low speeds to accommodate an increased turndown ratio, a wider airflow range, and decreased energy consumption as compared to typical pressure independent motor programs.

* + - * 1. Pressure Independent Program

A pressure independent program shall be provided to allow the ECM to compensate for fluctuations in external static pressure, providing constant airflow.

The air volume flow rate shall be maintained to within five percent of desired flow in a system with up to 0.50 inches water gauge of external static pressure.

* + 1. [Optional] ECM Deluxe Controller:
			1. Provides digital display of airflow and motor RPMs on controller
			2. Includes buttons on the face of the controller for adjustments
			3. RPM feedback available to BACnet
1. Electrical Requirements:
	1. Fan powered units shall be provided with single-point power electrical and control connection for the entire unit.
	2. The unit equipment wiring shall comply with the requirements of NFPA 70.
	3. The units shall be ETL listed to meet UL1995 and CSA 236.
	4. All high voltage electrical components shall be enclosed in a single control box with an access panel mounted on the side of the assembly.
2. Blower:
	1. Fan blower shall be galvanized steel construction with forward curved blades and a dynamically balanced wheel.
3. Controls [Booster configuration only]:
	1. Description:
		1. Furnish and install Price model UMCB, with the voltage, wiring, and configurations indicated on the plans and controllers schedule.
		2. The control package shall include a modulation controller capable of accepting two 0-10 VDC signals from a zone DDC controller, one for heating and one for cooling.
		3. The UMCB shall be a dedicated, micro-processor-based controller mounted in the underfloor plenum.
			1. The controller shall modulate the actuators of up to 12 point-of-use terminal units based on the cooling and heating loads from the input signals via RJ12 type terminations for plug and play wiring of up to 12 ModuFlex cooling only devices
			2. The controller shall house input terminations for the input signals and up to three analog peripheral devices, such as temperature probes, differential pressure sensor, or connection to contact closure night setback.
			3. The controller shall house terminations for ECM fan control, auxiliary digital output and analog, modulating, or three stages of digital heat.
			4. The controller shall be capable of PWM heat output for electric heaters using an SSR.
			5. The controller shall have LED display lights to indicate availability of control power, the state of up to three stages of digital heat, state of auxiliary output and box fan.
		4. All components shall be factory wired, calibrated, and pre-tested to ensure a fully functional unit.
	2. Thermostat [Optional]:
		1. The control package shall include a remote Price Thermostat mounted in the occupied zone and a box mounted modulation controller.
		2. Options include:
			1. Room Sensor
			2. Dial
			3. LCD
			4. LCD w/ Motion Sensor
			5. LCD w/ CO2 and Humidity Sensor
			6. Wireless Dial
		3. The control package shall also include a [15 ft.] [25 ft.] [35 ft.] plenum rated CFLEX thermostat cable with plug and play RJ45 connections.
	3. Technical Specifications:
		1. Inputs: 4 analog inputs – 10 bit plus 2 binary inputs
		2. Outputs: 8 binary triac outputs (24 VAC, max 5A each) plus 3 universal outputs
		3. Power: 24 VAC with visual LED status, 5 VA (not including output loading)
		4. Ambient Ratings: 32 °F to 131 °F (0 to 55°C), 10 to 90% RH (non-condensing)
		5. Technology: 8-bit microprocessor
		6. Connections: 2 RJ45 connectors, 2 MTA156 connectors, 2 MTA100 connectors, and pluggable screw type terminal connectors
		7. Wiring: Class II
		8. Weight: 0.64 lb (290 g)
	4. Interfacing to EMS/BMS/BAS:
		1. The zone controller shall interface with the building management system (BMS) to allow remote monitoring of room parameters or permit settings adjustments over the building network.
		2. The BMS shall use BACnet MS/TP network protocol to view points or status of room space. The use of BACnet protocol shall be native to the device and shall not require the use of an external gateway.
		3. The thermostat shall include the ability to change the MAC address, device instance and baud rates (9600, 19200, 38400, 76800) for proper interfacing to BACnet network.
		4. The zone controller shall support on board network termination for the MS/TP network.
		5. The zone controller shall be BTL listed.
		6. The manufacturer shall be a member of BACnet International.
		7. All temperature set points and VAV airflows shall be adjustable from the BACnet network.
	5. Certifications:
		1. The UMCB shall be ETL listed to UL 1995 and CSA C22.2.
	6. Enclosure:
		1. All control components shall be mounted inside a protective metal enclosure.
4. Mounting/Fastening:
	1. The owner shall confirm exact location of floor pedestals on site. The units shall be mounted on the main slab beneath the raised floor. The unit shall not be suspended from the raised floor.
	2. Mounting brackets include rubber vibration-isolation pads.
5. Options:
	1. Water Cooling and Heating Coils:
		1. All water coils shall be rated and certified in accordance with the current edition of AHRI 410, and shall bear the AHRI seal on the unit casing.
		2. All cooling and heating coils shall optimize rows and circuits to meet the specified capacity.
		3. All standard coils are 12 FPI.
		4. Coils shall have seamless copper tubes and shall be mechanically expanded to provide an efficient, permanent bond between the tube and fin.
		5. Fins shall have a high efficiency aluminum surface optimized for heat transfer, air pressure drop and carryover.
		6. All coils shall be hydrostatically tested at 390 pounds per square inch minimum air pressure, and rated for a maximum of 300 pounds per square inch working pressure at 200 degrees Fahrenheit.
		7. Cooling and heating coils shall be in separate coil casings.
			1. HCCO coils combine heating and cooling in a single coil and shall be in a single casing.
		8. Units with cooling coils shall be supplied with an integral condensate diverting section to prevent condensate carry over in cases of air velocities over 350 feet per minute. Coils are not recommended to operate above 500 feet per minute.
		9. Reheat Configuration available
			1. In reheat configuration, a two-pipe cooling coil is installed upstream of a two pipe hot water coil.
			2. No diverter section is present in reheat configurations.
		10. Drain Pans:
			1. All units with cooling coils shall be supplied with a primary drain pan with single wall, galvanized steel for corrosion resistance.
			2. The primary drain pan shall extend under the entire cooling coil and heating coils as well for 4 pipe reheat configurations.
			3. Drain pans shall be of one-piece construction and be positively sloped for condensate removal.
			4. Drain pans shall be externally insulated with fire retardant foam insulation. The insulation shall carry no more than a 25/50 Flame Spread and Smoke Developed Rating per ASTM E84 and UL 723 and an Antimicrobial Performance Rating of zero with no observed growth per UL 181.
			5. (**Optional**): Provide primary drain pan with type 304 stainless steel construction for superior corrosion resistance. Stainless steel drain pans shall be externally insulated and meet or exceed the requirements stated above.
			6. (**Optional**): Provide an auxiliary drain pan for overflow protection of the primary drain pan.
			7. (**Optional**): Provide an overflow safety switch on drain pan.
			8. Drain pans shall be shipped loose.
	2. Electric Heating Coil:
		1. The electric heating coil shall be ETL listed to UL1995 and CSA C22.2 No. 236, and provided by the fan powered unit manufacturer.
		2. The electric coil casing shall be constructed from a minimum 20 gauge galvanized steel.
		3. The heating elements shall be open wire nickel chrome construction, supported by ceramic insulators.
		4. The integral controls enclosure shall be a NEMA 250, Type 1 enclosure with rivet-hinged top access door for access to most controls and safety devices.
		5. The electric coils shall be provided with a primary automatic reset thermal cutout, a secondary manual reset thermal cutout, and an electrical fan interlock to prevent heater operation when the fan is not running.
		6. Magnetic contactors shall be supplied for each stage of heat.
		7. [**Optional**] The electric coils may be provided with a door complete with interlocking disconnect switch, multiple stages, SCR control, insulation, airflow sensors, and dual point power connection.
	3. Return Damper Assembly [Terminal configuration only]:
		1. The damper assembly shall be heavy-gauge, galvanized steel with a solid shaft rotating in bushings.
		2. The damper shaft shall incorporate a visual position indicator etched into the end of the damper shaft to clearly indicate damper position over the full range of 90 degrees.
			1. The damper shaft shall be mounted on the [left], or [right] of the damper when looking in the direction of airflow.
		3. The low leakage 18 gauge damper assembly shall incorporate a peripheral gasket on the damper blades for tight airflow shutoff.
		4. Inlet Valve:
			1. The inlet valve shall be a rectangular inlet.
			2. The gasket seal shall be a low leakage continuous piece with a peripheral gasket for tight airflow shutoff.
			3. The inlet valve shall include two heavy-duty stop pins to accurately position the damper in the closed and open positions.
	4. Inlet Damper Assembly [Booster configuration only]:
		1. The damper assembly shall be heavy-gauge, galvanized steel with a solid shaft rotating in bushings.
		2. The damper shaft shall incorporate a visual position indicator etched into the end of the damper shaft to clearly indicate damper position over the full range of 90 degrees.
			1. The damper shaft shall be mounted on the [left], or [right] of the damper when looking in the direction of airflow.
		3. The low leakage 18 gauge damper assembly shall incorporate a peripheral gasket on the damper blades for tight airflow shutoff.
		4. Inlet Valve:
			1. The inlet valve shall be a rectangular inlet.
			2. The gasket seal shall be a low leakage continuous piece with a peripheral gasket for tight airflow shutoff.
	5. The inlet valve shall include two heavy-duty stop pins to accurately position the damper in the closed and open positions.
	6. Plenum Return Filter
		1. The plenum return shall be supplied with fiberglass filters.
		2. When tested in accordance with ASHRAE 52.2, the filter shall have a Minimum Efficiency Reporting Value of:
			1. MERV 3 filter.
	7. Sound Attenuator
		1. The manufacturer shall provide a close-coupled sound attenuator, as required, to meet scheduled acoustical performance requirements.
		2. Attenuator shall be shipped loose.
		3. Attenuator shall be the following configuration:
			1. Discharge Attenuator (DAS).
				1. Four foot discharge attenuator
				2. Liner options:

½” Fiberglass insulation (DAS-FG50)

½” Fiber-free insulation (DAS-FF50)

* + 1. The manufacturer shall provide an AHRI certified assembly complete with an acoustically tuned attenuator
	1. Chicago Building Code 2000 Compliant Control Enclosures
		1. Enclosures shall be “toothpick” proof to reduce the chance of smoke exfiltration.
			1. All wires leaving the control enclosures shall be run through conduits
			2. Any openings shall be sealed with rubber grommets or gasketing.

# PART 3 - EXECUTION

## 3.01 Examination

1. Verify that conditions are suitable for installation.
2. Verify that field measurements are as shown on the drawings.

## 3.02 Installation

1. Install the units in accordance with the manufacturer's instructions.
2. Install underfloor fan powered units level and plumb. Maintain sufficient clearance for normal services, maintenance, or in accordance with construction drawings.
3. Complete installation and startup checks according to manufacturer’s instructions and perform the following:
	* 1. Verify that inlet duct connections are as recommended by the manufacturer to achieve proper performance.
		2. Verify that any identification tags are visible.
		3. Verify locations of thermostats, humidistats, and other exposed control sensors with drawings and room details before installation

**3.03 Adjusting**

 A. Ensure the damper operator attached to the assembly allows full modulation of flow range from 100 percent of design flow to zero.

**3.04 Field Quality Control**

 A. See Section 01 40 00 - Quality Requirements, for additional quality requirements.

**3.05 Cleaning**

 A. See Section 01 74 19 - Construction Waste Management and Disposal for additional cleaning requirements.

## 3.06 Closeout Activities

1. See Section 01 78 00 - Closeout Submittals for closeout submittals.
2. See Section 01 79 00 - Demonstration and Training for additional closeout requirements.